



Contents lists available at ScienceDirect

Journal of Forensic and Legal Medicine

journal homepage: www.elsevier.com/jflm

Case Report

Circumscribed injuries caused by an explosion in firecracker factory

K.R. Nagesh MD (Associate Professor)^{a,*}, Ritesh G. Menezes MD DNB (Associate Professor)^b,
B. Suresh Kumar Shetty MD (Associate Professor)^b, Anand Menon MD (Professor and Head)^b

^a Department of Forensic Medicine, Father Muller Medical College, Mangalore 575 002, Karnataka, India

^b Department of Forensic Medicine, Kasturba Medical College, Mangalore 575 001, Karnataka, India

ARTICLE INFO

Article history:

Received 15 May 2009

Received in revised form 9 October 2009

Accepted 22 December 2009

Available online 22 January 2010

Keywords:

Firecracker

Firecracker injuries

Explosion

Blast injury

Multiorgan failure

ABSTRACT

Firecracker display is used worldwide for celebrating religious festivities, New Year celebrations and various other occasions. Explosion during the manufacture of firecrackers can result in serious injuries. We, herein, report a case, where a person succumbed to injuries sustained in an explosion in a firecracker factory. Superficial to deep burns, traumatic amputation of right upper limb, and multiple abrasions and lacerations were present on various parts of the body with contusion of internal thoracic and abdominal organs. Also, multiple punctured circumscribed wounds with burnt floor and margins were present over the body.

© 2009 Elsevier Ltd and Faculty of Forensic and Legal Medicine. All rights reserved.

1. Introduction

Fireworks are used throughout the world for celebrating various National and cultural events.^{1–4} Injuries due to fireworks are frequently reported and it involves commonly the hands, face and eyes.^{5–7} Several cases have been reported on explosions in the work place of firecracker manufacturing units that resulted in severe injuries and mortality.^{8–10}

Explosion in a firecracker factory are caused by either carelessness while manufacturing fireworks, sparks resulting from short-circuit of an electric circuit, or exposing the damp gunpowder to outdoors in summer.⁹ Injuries in an explosion in firecracker factory commonly involve the head and neck, followed by the upper and lower limbs and the trunk, with the buttock and perineum least likely to be injured. Usual injuries include burns, fractures of limb bones, barotraumas involving the lungs and middle ear, and damage to abdominal internal organs, etc.^{9,11}

We report a case where a person sustained some characteristic circumscribed injuries in an explosion in a firecracker factory with fatal consequences.

2. Case report

An explosion occurred in a legalized firecracker factory on first January at about 15.30 h. A partially burnt storehouse with damaged walls and scattered materials used for preparing the firecrackers were found at the scene of incidence. In this incident, a 22-year-old man sustained severe injuries. In the hospital, the patient was in a semiconscious state with Glasgow coma scale 5/15. The right hand and lower half of forearm was missing with lacerated soft tissues and fractured bones covered by debris and gun powder. An active bleeding was present from the right elbow. Extensive burn injuries on various parts of the body with multiple lacerations, abrasions and contusions were present. A circular metallic piece was found in the depth of punctured wounds over the chest and right upper thigh. The wounds were cleaned and surgically debrided. Above elbow amputation was done on right side to control bleeding with the supportive treatment. The investigations include total leukocyte count 19,800 mm³ (4000–11,000 mm³), total bilirubin 1.8 mg/dl (0.1–1.0 mg/dl), AST 398 U/L (15–40 U/L), ALT 295 U/L (10–40 U/L), total protein 4.5 g/dl (6–8.2 g/dl), albumin 2.1 g/dl (3.5–5.2 g/dl), blood urea nitrogen 69 mg/dl (8–21 mg/dl) and serum creatinine 1.8 mg/dl (0.3–1.2 mg/dl). The arterial blood gas analysis showed hypoxemia with pO₂ 46.9 mmHg (80–100 mmHg). The total survival period was 84 h.

Postmortem examination revealed superficial to deep burn injuries involving the entire body except the back and left side of head, left side of neck, front of left chest and abdomen, upper

* Corresponding author. Mobile: +91 9845775907; fax: +91 824 2436352.

E-mail addresses: drnag2002@rediffmail.com (K.R. Nagesh), mangalore971@yahoo.co.in (R.G. Menezes), bellisks@rediffmail.com (B. Suresh Kumar Shetty), anandski@rediffmail.com (A. Menon).

and medial aspects of buttocks, groin, and medial aspect of both thighs. The total body surface area burnt was 75%. Right upper limb was amputated surgically above the level of elbow. The examination of oral cavity and ears revealed no injuries. External injuries include laceration over the right forehead and right postero-lateral surface of abdomen. Multiple tiny abrasions and contusions with blackish staining of skin were present over the anterior surface of chest and right side of abdomen. Surgically debrided lacerated wound measuring 17 cm × 11 cm × muscle deep was present obliquely over the lateral surface of right thigh, with multiple superficial lacerations with burnt margins around it (Fig. 1).

Also, there are some characteristic wounds present on the body. Two oval shaped punctured wounds were present on the anterior surface of right chest, one measuring 3 cm × 2 cm situated at the upper chest and another measuring 4 cm × 2.5 cm situated at the middle part of chest (Fig. 2). A circular shaped punctured wound measuring 4 cm in diameter was present over the antero-lateral surface of right upper thigh (Fig. 3). The wounds were extended up to the depth of muscles with burnt margins and floor of the wounds. The diagrammatic presentation of distribution of injuries was shown in Fig. 4.

Internal examination revealed an edematous brain and contusion of posterior chest wall on both sides with serous fluid in both pleural cavities. Both lungs were edematous with the right and left lungs weighed 650 g and 595 g, respectively with contusion on posterior surfaces of the lower and middle lobes. Pericardium and heart were intact with patent coronaries. Serous fluid was present in the peritoneal cavity with intact organs except the liver, where contusion was present on postero-lateral surface.

Histopathology of lungs revealed pulmonary edema, widened alveolar septa with vascular congestion, and formation of intra alveolar hyaline membrane. Sections from liver showed large vascular thrombi in the portal tract. Sections from kidneys showed deposition of thrombi made up of amorphous hyaline material in the glomerular capillaries and congested capillaries in the interstitium. The cause of death was opined as multiorgan failure.

3. Discussion

Firecrackers are usually made up of gun powder, which contains charcoal, sulphur and potassium nitrate. Flash powder is used as an explosive component of firecrackers, which is a chemical mixture consisting of potassium perchlorate and finely powdered aluminium. Firecrackers are grouped under 'low-order explosives', which



Fig. 1. Surgically debrided laceration over the lateral surface of right thigh and surrounding superficial lacerations with burnt margins.



Fig. 2. Punctured wounds with burnt margins and floor over the right chest.



Fig. 3. Punctured wound with burnt margins and floor over the antero-lateral surface of right thigh.

burn at a steady speed and can be detonated under extreme circumstances. Injuries resulting from these explosives are caused by fragments of the container, blast wind from expanding gases, and thermal injuries associated with the heat of the explosion.¹¹ Also, in an enclosed space, the reflection of blast waves from walls creates complex waves of longer duration, which allows greater transfer of energy to the body.¹²

In the present case, the injuries were mainly present on right side of the body, which indicates that blast occurred on right side of the body. The heat produced by an explosion has resulted in thermal injuries involving 75% of body surface area. The blast waves created by the explosion have resulted in traumatic

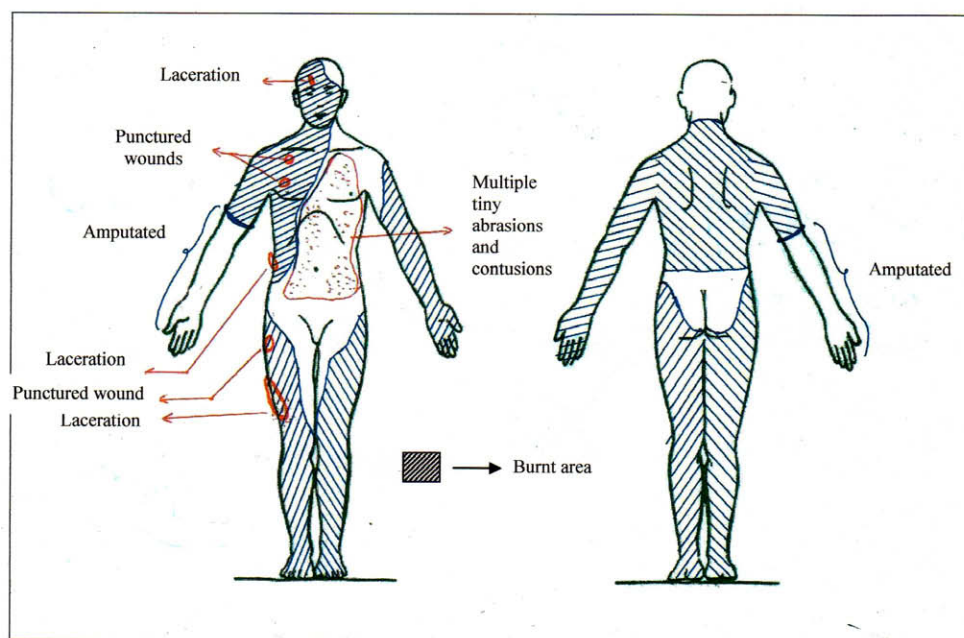


Fig. 4. Diagrammatic presentation of distribution of injuries on the body.

amputation of the right hand and forearm and also, contusions of posterior chest wall, lungs and liver. The flying missiles from fragmented pieces of the firecrackers and containers due to the explosion caused multiple abrasions and lacerations over the scalp, chest, abdomen and right thigh. Apart from this, peculiar multiple punctured wounds with burnt floor and margins were present over the right chest and thigh. The circular metal pieces that are used to seal the base of a firecracker have pierced the skin and muscles causing the punctured wounds, and adhered gunpowder has burnt the floor and margins of the wound.

The morbidity and mortality is quite high in an explosion in firecracker factory due to severity of injuries and its complications viz., hypovolaemic shock, septicemia, acute respiratory distress syndrome, acute renal failure, multiorgan dysfunction syndrome, etc.^{9,10} In the present case, the patient developed acute respiratory distress syndrome with deranged liver and renal functions, which led to a conclusion of multiorgan failure as the cause of death.

Conflict of Interest

None declared.

Funding

None.

Ethical Approval

Not applicable.

References

1. Vassilia K, Eleni P, Dimitrios T. Firework-related childhood injuries in Greece: a national problem. *Burns* 2004;**30**:151–3.
2. Zohar Z, Waksman I, Stolerio J, Volpin G, Sacagiu E, Eytan A. Injury from fireworks and firecrackers during holidays. *Harefuah* 2004;**143**:698–701.
3. Al-Qattan MM, Al-Tamimi AS. Localized hand burns with or without concurrent blast injuries from fireworks. *Burns* 2009;**35**:425–9.
4. Puri V, Mahendru S, Rana R, Deshpande M. Firework injuries: a ten-year study. *J Plast Reconstr Aesthet Surg* 2009;**62**:1103–11.
5. See LC, Lo SK. Epidemiology of fireworks injuries: the National Electronic Injury Surveillance System, 1980–1989. *Ann Emerg Med* 1994;**24**:46–50.
6. Morell T, Lohmann M, Basse PN. Injuries due to fireworks. *Ugeskr Laeger* 1992;**154**:3736–8.
7. Fogarty BJ, Gordon DJ. Firework related injury and legislation: the epidemiology of firework injuries and the effect of legislation in Northern Ireland. *Burns* 1999;**25**:53–6.
8. Harding BA, Wolf BC. Independence day explosion on lovers key. *J Forensic Sci* 2007;**52**:1186–9.
9. Chen XL, Wang YJ, Wang CR, Hu DL, Sun YX, Li SS. Burns due to gunpowder explosions in fireworks factory: a 13-year retrospective study. *Burns* 2002;**28**:245–9.
10. Chen XL, Wang YJ, Wang CR, Li SS. Gunpowder explosion burns in fireworks factory: causes of death and management. *Burns* 2002;**28**:655–8.
11. Wallace GL. Blast injury basics: a guide for the medical speech-language pathologist. *ASHA Leader* 2006;**11**:26–8.
12. Chaloner E. Blast injury in enclosed spaces. *BMJ* 2005;**331**:119–20.